Technical Report 883

The Incremental Validity of Spatial and Perceptual-Psychomotor Tests Relative to the Armed Services Vocational Aptitude Battery

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March 1990

United States Army Research Institute
for the Behavioral and Social Sciences

U.S. ARMY RESEARCH INSTITUTE
FOR THE BEHAVIORAL AND SOCIAL SCIENCES

A Field Operating Agency Under the Jurisdiction of the Deputy Chief of Staff for Personnel

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UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE

REPORT DOCUMENTATION PAGE

Form Approved OMB No. 0704-0188

1a. REPORT SECURITY CLASSIFICATION Unclassified	1b. RESTRICTIVE MARKINGS --
2a. SECURITY CLASSIFICATION AUTHORITY -- 2b. DECLASSIFICATION / DOWNGRADING SCHEDULE --	3. DISTRIBUTION / AVAILABILITY OF REPORT Approved for public release; distribution is unlimited.
4. PERFORMING ORGANIZATION REPORT NUMBER(S) ARI Technical Report 883	5. MONITORING ORGANIZATION REPORT NUMBER(S) --
6a. NAME OF PERFORMING ORGANIZATION U.S. Army Research Institute 6b. OFFICE SYMBOL (If applicable) PERI-RS	7a. NAME OF MONITORING ORGANIZATION --
6c. ADDRESS (City, State, and ZIP Code) 5001 Eisenhower Avenue Alexandria, VA 22333-5600	7b. ADDRESS (City, State, and ZIP Code) --
8a. NAME OF FUNDING / SPONSORING ORGANIZATION U.S. Army Research Institute for the Behavioral and Social Sciences 8b. OFFICE SYMBOL (If applicable) PERI-R	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER --
8c. ADDRESS (City, State, and ZIP Code) 5001 Eisenhower Avenue Alexandria, VA 22333-5600	10. SOURCE OF FUNDING NUMBERS PROGRAM ELEMENT NO. 63731A; PROJECT NO. 792; TASK NO. 2202; WORK UNIT ACCESSION NO. H1

11. TITLE (Include Security Classification)
The Incremental Validity of Spatial and Perceptual-Psychomotor Tests Relative to the Armed Services Vocational Aptitude Battery

12. PERSONAL AUTHOR(S)
Busciglio, Henry H. (ARI)

13a. TYPE OF REPORT	13b. TIME COVERED	14. DATE OF REPORT (Year, Month, Day)	15. PAGE COUNT
Final	FROM 89/07 TO 89/11	1990, February	

16. SUPPLEMENTARY NOTATION
Prepared under Project A: Improving the Selection, Classification, and Utilization of Army Enlisted Personnel (U.S. Army Research Institute)

17. COSATI CODES		
FIELD	GROUP	SUB-GROUP

18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)
Concurrent validation
Predictor and criterion measures
Personal selection and classification
Project A

19. ABSTRACT (Continue on reverse if necessary and identify by block number)

This research evaluates the utility of new Army tests of spatial, perceptual, and psychomotor abilities developed under the Army's Project A (Improving the Selection, Classification, and Utilization of Army Enlisted Personnel). Utility is judged in terms of incremental validity over the Armed Services Vocational Aptitude Battery (ASVAB). The analyses are stepwise regressions using predictors and performance tests from the 1985 Concurrent Validation of Project A. A variety of performance measures, ranging from comprehensive to task-level, served as criteria for the analyses. In the analyses, optimal combinations of Project A predictors substantially augmented the proportion of criterion variance explained by optimal combinations of ASVAB scores alone, particularly for such comprehensive measures as General Soldiering Proficiency and the combined score on written tests of school and job knowledge. In certain Military Occupational Specialties (MOS), Project A scores led to increments in the predictability of more specific criteria, such as Target Identification and Navigation. While no strong support was found for the relative superiority of spatial

(Continued)

20. DISTRIBUTION / AVAILABILITY OF ABSTRACT ☒ UNCLASSIFIED/UNLIMITED ☐ SAME AS RPT. ☐ DTIC USERS	21. ABSTRACT SECURITY CLASSIFICATION Unclassified
22a. NAME OF RESPONSIBLE INDIVIDUAL Michael G. Rumsey	22b. TELEPHONE (Include Area Code) (202) 274-8275 22c. OFFICE SYMBOL PERI-RS

DD Form 1473, JUN 86 Previous editions are obsolete.

SECURITY CLASSIFICATION OF THIS PAGE
UNCLASSIFIED

ARI Technical Report 883

19. ABSTRACT (Continued)

versus perceptual-psychomotor scores, there was evidence that some individual tests (viz., Assembling Objects, Figural Reasoning, and Target Identification) were much more useful than others as incremental predictors of the criteria. Because of the concurrent design used and the lack of opportunities for cross-validation, these generally favorable findings only suggest the results to be expected from the Longitudinal Validation of Project A.

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March 1990

Army Project Number
2Q263731A792

Manpower and Personnel

FOREWORD

This document describes a set of new analyses performed on data gathered during a 1985 validation of proposed new tests in a long-term, comprehensive effort to improve the selection and classification of enlisted personnel called Project A. In this phase of Project A, predictors included tests of spatial and perceptual-psychomotor abilities were administered to 9,500 soldiers in 19 Military Occupational Specialties (MOS). Previous used unit-weighted composites of standardized test scores and did not address the issue of their individual contributions. The main purpose of the present set of analyses was to determine which individual spatial and perceptual-psychomotor tests could be most useful for improving the Army's selection and classification decisions now being made using the Armed Services Vocational Aptitude Battery (ASVAB) alone.

Project A tests were found to substantially improve the prediction of many performance criteria, most notably such comprehensive measures as General Soldiering and Core (i.e., MOS-specific) Technical Proficiency. Sizable incremental validities were also found for some narrower criteria, including Navigation and Target Identification. Perhaps the most important finding was that some Project A tests might be used for augmenting the prediction of a wide variety of criteria. These results will undoubtedly prove useful in the analysis and interpretation of data collected in later, more extensive phases of Project A.

With a smaller Army being planned, the need for more effective selection and classification decisions becomes more acute. The results of these analyses are relevant to this issue, since the analyses support the usefulness of Project A tests of spatial and perceptual-psychomotor abilities in general and also strongly indicate which individual measures may be most useful to the Army in the future.

A portion of these results has been reported to the Military Accession Policy Working Group to aid in selecting tests to be included in the Enhanced Computer Assisted Testing (ECAT) program. The ECAT program is a joint-service effort to improve upon the prediction of performance by adding some perceptual-psychomotor tests and computerized versions of some spatial tests to ASVAB.

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ACKNOWLEDGMENTS

I would like to thank the following individuals for their valuable assistance

Army Research Institute -
Dr. Clinton Walker
Dr. Jacinto Silva
Ms. Frances Grafton

American Institutes for Research -
Dr. Lauress Wise

Special thanks also to Dr. Michael Rumsey, Selection and Classification Technical Area Chief, and to Drs. Fred Mael and Jane Arabian for their astute and constructive comments on earlier drafts of this paper.

THE INCREMENTAL VALIDITY OF SPATIAL AND PERCEPTUAL-PSYCHOMOTOR TESTS RELATIVE TO THE ARMED SERVICES VOCATIONAL APTITUDE BATTERY

EXECUTIVE SUMMARY

Requirement:

To evaluate the potential usefulness of new tests of spatial and perceptual-psychomotor abilities developed in the Army's Project A, a long-term, comprehensive effort to improve the selection and classification of enlisted personnel. Project A objectives include the assessment of the ability of the Armed Services Vocational Aptitude Battery (ASVAB) to predict both existing and project-developed measures of performance, as well as the development and validation of new measures. In one phase of this effort, a set of Project A tests was administered in 1985 to 9,500 soldiers in 19 Military Occupational Specialties (MOS). The purpose of the present analysis of the 1985 Project A data was to assess the usefulness of individual ASVAB subtests and Project A tests for selecting and/or classifying soldiers.

Procedure:

Multiple regression analyses were used to answer the following:

(1) How good are the individual ASVAB scores for predicting various types of performance, and how much is the prediction improved when the Project A spatial and perceptual-psychomotor scores are added?

(2) Is either <u>type</u> of test, spatial or perceptual-psychomotor, generally more useful for improving upon ASVAB?

(3) Which <u>specific</u> spatial or perceptual-psychomotor scores will be most useful?

Findings:

<u>Research Question 1.</u> Project A test scores substantially improved the prediction of many criteria, most notably three comprehensive measures of success: total score on written tests of school and job knowledge, General Soldiering Proficiency, and Core (i.e., MOS-specific) Technical Proficiency. Sizable improvements in the prediction of certain narrower criteria, such as Target

Identification and Determination of Grid Coordinates, were also found. Improvements in the prediction of some criteria, including the Skill Qualification Test (SQT), were more specific to MOS. Contrary to expectations, the usefulness of Project A tests for improving the prediction of some narrow MOS-specific criteria was quite small.

Research Question 2. In general, the spatial and perceptual-psychomotor tests were approximately equal in improving the prediction of the criteria.

Research Question 3. Among the ASVAB subtests, Math Knowledge and Auto/Shop were especially strong predictors of the criteria overall. The Project A tests that were the most useful for improving the prediction of the criterion measures included Assembling Objects, Figural Reasoning, and Map among the spatial tests, and Target Identification (% correct and decision time) and Short Term Memory (% correct) among the perceptual-psychomotor scores. Other Project A tests (e.g., Maze, Target Shoot, Simple Reaction Time) were more limited in their usefulness.

Utilization of Findings:

The results of these analyses indicate that the use of Project A spatial and perceptual-psychomotor tests can be expected to lead a more effective selection and classification decisions across a wide variety of entry-level Army MOS. A subset of these results has been reported to the Military Accession Policy Working Group to support the choice of tests for the Enhanced Computer Assisted Testing (ECAT program). The ECAT program is a joint-service effort to improve upon the prediction of performance by adding some perceptual-psychomotor tests and computerized versions of some spatial tests, to ASVAB.

THE INCREMENTAL VALIDITY OF SPATIAL AND PERCEPTUAL-PSYCHOMOTOR TESTS RELATIVE TO THE ARMED SERVICES VOCATIONAL APTITUDE BATTERY

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THE INCREMENTAL VALIDITY OF SPATIAL AND PERCEPTUAL-PSYCHOMOTOR TESTS RELATIVE TO THE ARMED SERVICES VOCATIONAL APTITUDE BATTERY

The Army's Project A is a long-term, comprehensive effort to improve the selection and classification of enlisted personnel. One objective of this effort was to validate the Armed Services Vocational Aptitude Battery (ASVAB), the traditional instrument for assessing the general cognitive skills of potential soldiers. Previous analyses of Project A data (Campbell, 1988) demonstrated that the ASVAB is useful for predicting first tour performance, particularly such "can-do" criteria as General Soldiering Proficiency and Core (i.e., MOS-specific) Technical Proficiency. Therefore, the ASVAB serves as a baseline against which the marginal utility of other tests for selection and classification is judged.

Another objective of Project A was to develop and validate measures of abilities other than the general cognitive domain covered by ASVAB. For example, Project A staff members hypothesized that measures of spatial and perceptual-psychomotor abilities would account for criterion variance that was not predictable from ASVAB scores. In pursuit of this objective, a set of new Project A predictors was administered to 9,500 soldiers in 19 Military Occupational Specialties (MOS) in the 1985 Concurrent Validation phase. To date, analyses of the validity and incremental validity of these predictors have used unit-weighted composites of ASVAB and Project A test scores (Campbell, 1988), and have not addressed the issue of their individual contributions. The purpose of the present analysis of the 1985 Project A concurrent validity data was to assess the individual validities of ASVAB subtest scores and to answer three questions:

(1) How much criterion variance can empirically determined optimal combinations of spatial and perceptual-psychomotor tests account for over and above that predicted by an optimal combination of ASVAB subtests?

(2) Is either type of test, spatial or perceptual-psychomotor, generally more useful for incrementing the prediction of criterion variance? The administration of the paper-and-pencil spatial measures is much less costly and time-consuming than that of the perceptual-psychomotor tests. If the perceptual-psychomotor tests were found to be inferior to, or redundant with the spatial measures, the utility of their operational usage would be suspect.

(3) Which specific spatial or perceptual-psychomotor scores will have the highest individual contributions to this incremental validity?

Method

Subjects

Subjects were first-term enlisted personnel in the nine MOS for which hands-on criterion measures were collected as part of the 1985 Concurrent Validation phase of Project A. These MOS had been selected for comprehensive examination in Project A because they were judged to be representative of the entire population of entry-level Army MOS. The sample consists of individuals who had entered the Army between 1 July 1983 and 30 July 1984 and was drawn from thirteen posts in the continental United States as well as the U.S. Army in Europe (USAREUR). The number of subjects from each MOS, as well as the total sample size, is shown in Table 1.

Table 1

Subjects for the Present Analysis

MOS	Enlisted Job	N
11B	Infantry	491
13B	Cannon Crew	464
19E	Armor Crew	394
31C	Single Channel Radio Operator	289
63B	Light Wheel Vehicle Mechanic	478
64C (now 88M)	Motor Transport Operator	507
71L	Administrative Specialist	427
91A	Medical Specialist	392
95B	Military Police	597
TOTAL		4,039

Note. See Table 3 for the actual sample sizes used in all analyses.

Predictors

Predictors were the nine ASVAB subtests, the six Project A paper-and-pencil tests of spatial ability, and 14 selected scores from the ten Project A computerized perceptual-psychomotor tests. Detailed information concerning the nature and development of the Project A predictors can be found in Peterson (1987). Table 2 presents a list of these predictors, along with the specific perceptual-psychomotor scores used.

Table 2

Predictors Used in the Analysis

ASVAB Subtests:	Spatial Ability Tests:
Mechanical Comprehension	Assembling Objects
Auto/Shop Information	Map
Electronics Information	Maze
Math Knowledge	Object Rotation
Arithmetic Reasoning	Orientation
Verbal (Paragraph Comprehension + Word Knowledge)	Figural Reasoning
General Science	
Coding Speed	
Number Operations	

Perceptual-Psychomotor Tests and Scores:	
Target Tracking 1	- accuracy
Target Tracking 2	- accuracy
Target Shoot	- accuracy and time-to-fire
Cannon Shoot	- time discrepancy (from optimal)
Simple Reaction Time	- decision time
Choice Reaction Time	- decision time
Short-Term Memory	- decision time and proportion correct
Perceptual Speed and Accuracy	- decision time and proportion correct
Target Identification	- decision time and proportion correct
Number Memory	- response time

Criterion Measures

All criteria included in these analyses are "can-do" measures; that is, measures of proficiency in performing job duties. The criteria selected for analysis measure performance, or success, at a number of different levels of specificity, the most comprehensive of which are listed and described below.

Total Score on School and Job Knowledge Tests. School and job knowledge tests are written, multiple-choice measures of soldiers' technical knowledge pertinent to the various tasks performed in each MOS. Each school knowledge, or end-of-training test consists of 130-210 items, depending upon MOS (Davis, Davis, Joyner, & de Vera, 1987). The job knowledge tests are meant to measure knowledge of between 25 and 31 "critical tasks" and consist of 150-200 items, once again depending upon the particular MOS (Campbell, in preparation). Unlike items on the school knowledge tests, those on the job knowledge tests were selected during Project A to sample content broadly and to discriminate maximally among examinees. The total score is a

unit-weighted composite of standard scores on the school and job knowledge tests.

Total Score on Hands-On Tests. Hands-on (or job sample) tests are measures of soldiers' ability to actually carry out various tasks pertinent to each MOS. Depending upon the MOS, soldiers perform between 14 and 17 major job tasks (most of which are also represented on the written job knowledge tests).

General Soldiering Proficiency. General Soldiering and Core Technical Proficiency are the two "performance constructs" which the Project A staff created to account for the variance in "can-do" performance. General Soldiering Proficiency is a composite score on a variety of tasks common to many MOS (e.g., determining grid coordinates on maps, recognizing friendly vs. threat aircraft), as measured by written test items and hands-on tasks. That is, the composite is an aggregate across measurement methods. (MOS 11B was not scored on this measure.)

Core (i.e., MOS-specific) Technical Proficiency. This is defined as soldiers' ability to perform the tasks that are at the "core" of each MOS (i.e., those that define the MOS), the composite score being an aggregate of scores on written test items and hands-on tasks.

Skill Qualification Test Score (SQT). These are paper-and-pencil tests of MOS-specific technical knowledge developed by the U.S. Army Training and Doctrine Command for periodic testing of soldiers in their MOS. This was the only criterion analyzed which was not developed in Project A. (MOS 91A was not scored on this measure.)

It should be stressed that the comprehensive measures above are not mutually exclusive. For example, written and hands-on test scores were used in the computation of General Soldiering and Core Technical Proficiency, as well as the total scores for written and hands-on tests.

In contrast to the exploratory analyses performed on the comprehensive measures, a number of more specific criteria were analyzed because Project A researchers hypothesized that spatial and/or perceptual-psychomotor abilities would be especially important to successful performance on these measures. All these criterion scores are from hands-on measures, with the exception of Target Identification. This measure (not to be confused with the predictor test having the same name) is composed of written job knowledge tests. The more specific criteria include several functional categories developed in Project A by grouping critical tasks (as identified by job analyses) into clusters based upon similarity of content. The functional categories common to all or most of the nine MOS are listed and described directly below.

Navigation. The knowledge or ability necessary to "plan or execute movement between points over unknown terrain...or identify the location of objects" (Campbell, 1988, p. 80), as measured by hands-on tasks for all MOS except 11B.

Target Identification. The knowledge or ability to recognize friendly or threat vehicles and aircraft (Campbell, 1988, p. 81), as measured by items on the job knowledge tests for seven of the nine MOS (excluding 63B and 71L).

More specific than the common functional categories are the MOS-specific functional categories created in Project A. These measures were derived in the same way as the common functional categories, but are composed of tasks unique to a single MOS, and thus necessary to fully describe the task domains for most of the MOS. Researchers hypothesized that spatial and/or perceptual-psychomotor skills would be especially important to some of these measures, as listed and described below.

Operate Howitzer Sights and Align Devices (MOS 13B). Unique to Cannon Crewmen, it is the knowledge or ability necessary to "orient,lay a howitzer on an azimuth of fire using the howitzer sights, position aiming posts and the collimator, boresight, and engage direct fire targets from the assistant gunner's position" (Campbell, 1988, p. 82).

Tank Gunnery (MOS 19E). Unique to Armor Crewmen, it is the knowledge or ability necessary "in the preparation for engagement, conduct of fire, and actions after engagement with the tank weapons system" (Campbell, 1988, p. 82).

The most specific criterion analyzed was a hands-on measure of performance on an individual critical task.

Determine grid coordinates of a point on a map using the military grid reference system. This task is common to six of the nine MOS (excluding 11B, 13B, and 63B).

When interpreting the results below, readers should note that the more specific criteria form part of the comprehensive measures. For example, specific hands-on tasks were included in the total hands-on scores in each pertinent MOS. These may also form, along with the Target Identification written tests, a small part of General Soldiering and Core Technical Proficiency.

Procedure

Collection of Project A predictor and criterion data was part of the 1985 concurrent validation and occurred between 10 June and 13 November of that year. Scores on the ASVAB subtests and the Skill Qualification Test were obtained from archival data sources.

To answer the questions raised in the introduction, a series of backward stepwise multiple regression analyses were performed separately for each MOS. This procedure begins by entering all specified predictors into the equation as a block, and then removes nonsignificant predictors one by one, based upon their individual contributions to the overall R^2 with the criterion. This backward elimination procedure continues until all variables in the equation are individually significant at a certain probability level (the present analyses used .05).

The Army's selection and classification decisions are based on the ASVAB subtests. Because of this, restriction of range in the ASVAB scores (as well as any implicit range restriction in the measures which are correlated with them) would probably lead to underestimates of the actual criterion variance which would have been accounted for if ASVAB scores had not been used as a selection screen. To correct for this problem, matrices of estimated population (i.e., unrestricted) covariances among predictors and criteria were created, using the Lawley formula presented in Lord and Novick (1968; pp. 184-188), and used as input in these analyses. The R^2s reported below are in terms of this unrestricted population (the 1980 youth population, composed of individuals between the ages of 18 and 23) and have also been adjusted for shrinkage, using the formula given by Wherry (1940).

Employing an SPSS Regression program with both the "Enter" and "Backward Stepwise" subcommands, the analyses proceeded in the following three stages:

1. ASV ---> (ASV)

The nine ASVAB subtests were entered as a block into each equation and the backward procedure determined which were individually significant.

2. (ASV)+SP and (ASV)+P/M ---> (ASV+SP) and (ASV+P/M)

Significant ASVAB subtests were retained in a second stage of analysis, meaning that they were no longer subject to removal. In separate equations, the spatial or perceptual-psychomotor tests were entered as a block and retained only if they added individually significant variance to the R^2 obtained for ASVAB alone. This second stage produced two equations for each criterion variable. One contained the significant ASVAB and spatial tests, while the other was composed of significant ASVAB and perceptual-psychomotor predictors.

3. (ASV+SP)+P/M and (ASV+P/M)+SP

In the third stage, perceptual-psychomotor test scores were entered as a block into the equations containing significant

ASVAB and spatial tests (now also retained and thus no longer subject to removal) and were individually retained only if they significantly improved the prediction of the criterion measures. Also in this stage, spatial tests were entered as a block into the equations containing significant ASVAB and perceptual-psychomotor test scores (now retained) and were individually retained only if they added significantly to the R^2.

Data from all subjects were used in the analysis of the Project A comprehensive criteria. The sample sizes available for the other criterion measures were somewhat smaller, as shown in Table 3.

Table 3

Actual Sample Sizes Available for the Analyses

CRITERIA:	Project A Comprehensive	Skills Qualification	Target Ident.	Specific Hands-on
11B	491	444	482	0
13B	464	396	458	434
19E	394	338	371	378
31C	289	248	264	275
63B	478	409	0	443
64C (88M)	507	427	504	481
71L	427	361	0	416
91A	392	0	386	392
95B	597	545	576	577
TOTAL	4,039	3,168	3,041	3,396

Results

Incremental Validities Of Groups of Predictors

Descriptive data and findings pertinent to the psychometric properties of the measures used in these analyses have been reported extensively elsewhere (cf. Campbell, 1988). Table 4 shows the results of the analyses described above, in terms of the proportion of variance explained (R^2) by the significant predictors of each criterion measure. Concerning the overall incremental validity of Project A predictors (the first research question), Table 4 shows that the use of optimal combinations of spatial and perceptual-psychomotor test scores substantially improved the prediction of the criteria, most notably three comprehensive measures: Total Score on School and Job Knowledge Tests, General Soldiering Proficiency, and Core Technical Proficiency. Among the comprehensive measures, increases in the

Table 4

R^2s For Significant Predictors of Criterion Measures

Stage Predictors	(1) ASV	(2) (ASV)+SP	(3) (ASV+SP)+P/M	(2) (ASV)+P/M	(3) (ASV+P/M)+SP
Total Score on School and Job Knowledge Tests:					
11B	.59	.66	.66	.61	.66
13B	.39	.45	.47	.44	.48
19E	.58	.64	.65	.61	.65
31C	.60	.62	.65	.64	.65
63B	.63	.66	.67	.65	.67
64C	.55	.59	.60	.58	.60
71L	.54	.61	.63	.58	.62
91A	.67	.69	.70	.68	.70
95B	.62	.68	.69	.66	.69
MEDIAN	.59	.64	.65	.61	.65
Total Score on Hands-On Tests:					
11B	.21	.22	.26	.26	.26
13B	.06	.07	.09	.08	.08
19E	.17	.20	.20	.19	.21
31C	.41	.41	.43	.43	.43
63B	.12	.15	.18	.17	.17
64C	.29	.33	.33	.31	.33
71L	.31	.38	.40	.36	.40
91A	.36	.38	.39	.37	.39
95B	.39	.41	.41	.40	.41
MEDIAN	.29	.33	.33	.31	.33
General Soldiering Proficiency:					
11B	---	---	---	---	---
13B	.30	.33	.35	.34	.35
19E	.44	.50	.51	.46	.51
31C	.49	.52	.54	.52	.54
63B	.28	.33	.35	.33	.35
64C	.49	.53	.54	.52	.54
71L	.41	.48	.51	.47	.51
91A	.54	.56	.58	.56	.58
95B	.59	.64	.64	.62	.65
MEDIAN	.47	.51	.53	.50	.53

Table 4 (cont.)

R^2s For Significant Predictors of Criterion Measures

Stage Predictors	(1) ASV	(2) (ASV)+SP	(3) (ASV+SP)+P/M	(2) (ASV)+P/M	(3) (ASV+P/M)+SP
Core Technical Proficiency:					
11B	.48	.53	.54	.52	.54
13B	.15	.18	.20	.19	.20
19E	.35	.38	.40	.38	.40
31C	.54	.54	.56	.56	.56
63B	.48	.50	.50	.49	.51
64C	.32	.36	.36	.34	.36
71L	.44	.49	.52	.48	.51
91A	.58	.59	.60	.58	.60
95B	.43	.46	.47	.45	.47
MEDIAN	.44	.49	.50	.48	.51
Skill Qualification Test Score:					
11B	.44	.46	.48	.47	.48
13B	.19	.22	.22	.20	.22
19E	.40	.44	.45	.42	.44
31C	.55	.57	.57	.56	.57
63B	.55	.56	.57	.57	.58
64C	.50	.51	.53	.52	.53
71L	.58	.60	.62	.61	.62
91A	---	---	---	---	---
95B	.60	.61	.61	.60	.61
MEDIAN	.53	.54	.55	.54	.55
Navigation:					
13B	.26	.28	.28	.26	.28
19E	.18	.19	.19	.18	.19
31C	.26	.26	.28	.28	.28
63B	.01	.03	.04	.03	.03
64C	.38	.39	.40	.39	.40
71L	.15	.19	.20	.18	.19
91A	.20	.25	.25	.23	.25
95B	.25	.27	.27	.27	.27
MEDIAN	.23	.26	.26	.25	.26

Table 4 (cont.)

R^2s For Significant Predictors of Criterion Measures

Stage Predictors	(1) ASV	(2) (ASV)+SP	(3) (ASV+SP)+P/M	(2) (ASV)+P/M	(3) (ASV+P/M)+SP
<u>Target Identification</u>:					
11B	.21	.21	.24	.24	.24
13B	.16	.17	.20	.20	.20
19E	.13	.15	.19	.18	.18
31C	.12	.14	.14	.16	.16
64C	.06	.06	.06	.06	.06
91A	.23	.26	.28	.27	.28
95B	.14	.15	.16	.16	.16
MEDIAN	.14	.15	.19	.18	.18
<u>Operating Howitzer Sights</u>:					
13B	.02	.02	.04	.04	.04
<u>Tank Gunnery</u>:					
19E	.13	.14	.14	.13	.14
<u>Determining Grid Coordinates</u>:					
19E	.17	.19	.19	.17	.19
31C	.24	.25	.27	.27	.27
64C	.30	.31	.31	.31	.31
71L	.15	.19	.20	.17	.20
91A	.22	.26	.26	.24	.27
95B	.39	.42	.44	.41	.44
MEDIAN	.23	.26	.27	.26	.27

<u>Note</u>. ASV = Significant ASVAB predictors;
(ASV)+SP = Retained ASVAB and significant Spatial predictors;
(ASV+SP)+P/M = Retained ASVAB and Spatial predictors, plus significant Perceptual-Psychomotor scores;
(ASV)+P/M = Retained ASVAB and significant Perceptual-Psychomotor predictors;
(ASV+P/M)+SP = Retained ASVAB and Perceptual-Psychomotor predictors, plus significant Spatial scores.

median R^2s (across MOS) ranged from .02 for the Skill Qualification Test Score to .06 and .07 (differing by order of entry) for Core Technical Proficiency. Sizable incremental validities were also found for the narrower criteria of Target Identification and Determining Grid Coordinates. Among the narrower criteria, improvements in the median R^2s ranged from .01 for Tank Gunnery to .04 and .05 (differing by order of entry) for Target Identification.

Table 5 repeats the best results from Table 4 and shows the MOS and criterion measures for which the overall increment in R^2 based on both "Stage 3" equations was .05 or greater (an arbitrary cut-off). As shown, the use of Spatial and Perceptual-Psychomotor Test scores substantially improved the prediction of Total Score on School and Job Knowledge Tests and General Soldiering Proficiency in seven of the nine MOS. Sizable incremental validities were also found in one or more MOS for Total Score on Hands-on Tests, Core Technical Proficiency, Navigation, Target Identification, and Determining Grid Coordinates. Summarizing these results by MOS, the use of Project A scores improved the prediction of four comprehensive measures for 71L, three for 11B, 13B, and 19E, and two for 31C, 63B, 64C, and 95B, as well as a number of more specific criterion measures for 91A.

Regarding the relative usefulness of spatial vs. perceptual-psychomotor tests for incrementing the prediction of the criteria (the second research question), a hypothesis based on common method variance would be that the spatial tests would be more effective for the written criteria, the perceptual-psychomotor scores would be better incremental predictors of the hands-on criterion measures, and both types of predictors would be approximately equally effective for the criteria which have both written and hands-on components. Table 6 presents a summary of this analysis, in terms of median incremental R^2s (across MOS) of spatial vs perceptual-psychomotor predictors at Stage 2 - (ASV)+SP and (ASV)+P/M - of the backward stepwise procedure. As the table shows, spatial tests were slightly better than perceptual-psychomotor for improving the prediction of all three types of criteria. The one major exception is, not surprisingly, Target Identification, which the Target Identification test was specifically designed to predict.

Referring to the second research question in terms of specific MOS, Table 7 shows the MOS and criterion measures where the difference between the incremental R^2s associated with the two Stage 2 equations was .03 or greater (an arbitrary cut-off). The table shows some evidence that spatial tests, as a group, are somewhat superior to perceptual-psychomotor scores for improving the prediction, within one or more MOS, of Total Score on School and Job Knowledge Tests and General Soldiering Proficiency. Perceptual-psychomotor tests were better as incremental

Table 5

Best Incremental Validity Results from Table 4

Stage Predictors	(1) ASV	(2) (ASV)+SP	(3) (ASV+SP)+P/M	(2) (ASV)+P/M	(3) (ASV+P/M)+SP
Total Score on School and Job Knowledge Tests:					
11B	.59	.66	.66	.61	.66
13B	.39	.45	.47	.44	.48
19E	.58	.64	.65	.61	.65
31C	.60	.62	.65	.64	.65
64C	.55	.59	.60	.58	.60
71L	.54	.61	.63	.58	.62
95B	.62	.68	.69	.66	.69
Total Score on Hands-On Tests:					
11B	.21	.22	.26	.26	.26
63B	.12	.15	.18	.17	.17
71L	.31	.38	.40	.36	.40
General Soldiering Proficiency:					
13B	.30	.33	.35	.34	.35
19E	.44	.50	.51	.46	.51
31C	.49	.52	.54	.52	.54
63B	.28	.33	.35	.33	.35
64C	.49	.53	.54	.52	.54
71L	.41	.48	.51	.47	.51
95B	.59	.64	.64	.62	.65
Core Technical Proficiency:					
11B	.48	.53	.54	.52	.54
13B	.15	.18	.20	.19	.20
19E	.35	.38	.40	.38	.40
71L	.44	.49	.52	.48	.51
Navigation:					
91A	.20	.25	.25	.23	.25
Target Identification:					
19E	.13	.15	.19	.18	.18
91A	.23	.26	.28	.27	.28
Determining Grid Coordinates:					
71L	.15	.19	.20	.17	.20
95B	.39	.42	.44	.41	.44

Note. Incremental R^2s for both Stage 3 equations are equal to or greater than .05.

Table 6

Median Incremental R^2s (Across MOS) for Spatial and Perceptual-Psychomotor Tests at Stage 2

	Stage 2 Equation	
Criteria	(ASV)+SP	(ASV)+P/M
<u>Written</u>:		
Total Score on School and Job Knowledge Tests	.05	.02
Skill Qualification Score	.01	.01
Target Identification	.01	.04
<u>Hands-On</u>:		
Total Score on Hands-on Tests	.04	.02
Navigation	.03	.02
Operating Howitzer Sights	.00	.02
Tank Gunnery	.01	.00
Determining Grid Coordinates	.03	.03
<u>Composite</u>:		
General Soldiering Proficiency	.04	.03
Core Technical Proficiency	.05	.04

Table 7

Largest Differences in Incremental R^2s for Spatial and Perceptual-Psychomotor Tests at Stage 2

Criteria	Stage 2 Equation (ASV)+SP	Stage 2 Equation (ASV)+P/M
Total School/Job Knowledge:		
11B	.07	.02
19E	.06	.03
71L	.07	.04
Total Hands-On:		
11B	.01	.05
General Soldiering Proficiency:		
19E	.06	.02
Target Identification:		
11B	.00	.03
13B	.01	.04
19E	.02	.05

Note. Differences equal to or greater than .03.

predictors of Total Score on Hands-On Tests and Target Identification, once again within certain MOS.

Another aspect of the relative incremental value of spatial vs. perceptual-psychomotor tests is the extent to which their significance as predictors is independent of the order in which they were entered into the equations. For example, a spatial predictor which is significant both before and after the perceptual-psychomotor tests have been entered is more useful than one which is redundant with one or more perceptual-psychomotor tests, and thus loses its significance if entered after them. To explore this question, the number of equations, across criteria and MOS, in which each of the Project A tests was significant in both orders of entry, as well as only one, was determined. The results, as shown in Table 8, indicate that most of the Project A tests, when significant, were significant predictors in both orders of entry. Once again, there is a slight superiority for the spatial predictors overall.

Table 8

Number of Times Individual Predictors are Significant for Both or Only One Order of Entry, Across Criteria and MOS

	Both	(%[a])	Only One	(%)	Total
<u>Spatial Ability</u>:					
Assembling Objects	25	69.4	11	30.6	36
Figural Reasoning	22	73.3	8	26.7	30
Map	16	64.0	9	36.0	25
Object Rotation	7	58.3	5	41.7	12
Orientation	5	41.7	7	58.3	12
Maze	2	50.0	2	50.0	4
TOTAL	77	64.7	42	35.3	119
<u>Perc.-Psychomotor</u>:					
Target Id. - % correct	19	73.1	7	26.9	26
Target Id. - time	11	36.7	19	63.3	30
Memory - % correct	14	66.7	7	33.3	21
Number Memory - time	11	64.7	6	35.3	17
Tracking 2 - dist.	9	56.3	7	43.7	16
PSA - time	8	57.1	6	42.9	14
Tracking 1 - dist.	7	53.8	6	46.2	13
Cannon Shoot - time	7	58.3	5	41.7	12
Memory - time	6	75.0	2	25.0	8
PSA - % correct	3	37.5	5	62.5	8
Choice RT	4	66.7	2	33.3	6
Target Shoot - time	2	33.3	4	66.7	6
Target Shoot - dist.	1	50.0	1	50.0	2
Simple RT	0	-0-	2	100.0	2
TOTAL	102	56.4	79	43.6	181

[a] of Total.

<u>Incremental Validities of Individual Predictors</u>

The third research question concerns the validities and incremental validities of <u>individual</u> ASVAB and Project A test scores. Table 9 shows the number of regression equations in which each individual test is a significant predictor of the criterion measures across MOS. (To make the results comparable across groups of predictors, ASVAB scores will be noted as significant for both orders of entry.) As shown, certain ASVAB subtests and Project A tests were especially strong or weak as predictors or incremental predictors of the various criteria. Among the ASVAB scores, Mathematics Knowledge, Auto/Shop, and Mechanical Comprehension were particularly strong, while Arithmetic Reasoning, Coding Speed, Number Operations, and

Table 9

Number of Equations for Which Individual Predictors are Statistically Significant, by Type of Criteria, Across MOS

	Type of Criteria (Maximum Possible[a])						
	Compre-hensive (86)	Functional Categories Nav[b] (16)	IdTar (14)	Howit (2)	Tank (2)	Task Grid (12)	TOTAL (132)
<u>ASVAB</u>:							
Math Knowledge	68	14	4	0	0	10	96
Auto/Shop	74	6	6	0	0	8	94
Mechanical Comp.	48	10	2	2	2	6	70
General Science	38	0	12	0	2	2	54
Verbal	44	2	2	0	2	2	52
Arithmetic Reas.	26	2	2	0	0	4	34
Coding Speed	16	4	4	0	0	2	26
Number Operations	24	2	0	0	0	0	26
Electronics Info.	18	2	2	0	0	0	22
<u>Spatial Ability</u>:							
Assembling Objects	48	5	1	1	0	6	61
Figural Reasoning	40	4	0	0	0	8	52
Map	33	2	6	0	0	0	41
Object Rotation	14	2	1	0	2	0	19
Orientation	13	3	1	0	0	0	17
Maze	5	1	0	0	0	0	6
<u>Perc.-Psychomotor</u>:							
Target Id. - % correct	32	3	8	0	0	2	45
Target Id. - time	23	4	13	0	0	1	41
Memory - % correct	25	4	2	0	0	4	35
Number Memory - time	25	0	1	0	0	2	28
Tracking 2 - dist.	20	0	3	2	0	0	25
PSA - time	17	0	3	0	0	2	22
Tracking 1 - dist.	18	0	2	0	0	0	20
Cannon Shoot - time	11	5	1	0	0	2	19
Memory - time	10	2	0	0	0	2	14
PSA - % correct	10	1	0	0	0	0	11
Choice RT	8	2	0	0	0	0	10
Target Shoot - time	6	0	2	0	0	0	8
Target Shoot - dist.	3	0	0	0	0	0	3
Simple RT	1	0	1	0	0	0	2

[a] An example of the "maximum possible" is as follows: all nine MOS were evaluated on three of the comprehensive measures and eight on the remaining two, for a total of 43 - multiplying this

by 2 (orders of entry) gives 86 possible equations.

[b] Nav = Navigation;
IdTar = Target Identification;
Howit = Operating Howitzer Sights;
Tank = Tank Gunnery;
Grid = Determining Grid Coordinates.

Electronic Information were far less predictive. For the tests of spatial ability, Assembling Objects, Figural Reasoning, and Map were superior incremental predictors, while Maze was rather poor. Among the perceptual-psychomotor scores, both scores on the Target Identification test (proportion correct and decision time) and the proportion correct score on the Short Term Memory test were especially useful as incremental predictors. The scores on the Target Shoot test and the Simple and Choice Reaction Time tests were much less useful.

Another indication of the relative strengths and weaknesses of individual ASVAB subtests and Project A test scores is the proportion of variance in the criterion measures which they account for, over and above that explained by the other predictors in the equations. As discussed by Pedhazur (1982), this is indicated by the magnitude of their semi-partial correlations with the criteria. Table 10 shows median semi-partial correlations, across MOS, for the significant predictors of the comprehensive measures. As the table shows, most of the semi-partial correlations range between .05 and .10 and only a few of the tests correlated .10 or above with more than one or two criteria. The exceptions are Auto/Shop, Verbal, and Number Operations among the ASVAB subtests, and Assembling Objects, Map, and the percent correct score on the Short Term Memory Test among the Project A predictors.

Table 11 shows the number of regression equations for which the ASVAB and Project A tests were significant predictors of all criteria pertinent to the individual MOS (Appendixes A through H show these results separately for each criterion measure). The table indicates that the pattern of relative strengths and weaknesses displayed by the predictors in Table 9 is generally applicable to the individual MOS, with only a few notable exceptions. The Arithmetic Reasoning test, for example, appears more predictive in 71L than it is in general. This is also the case for the proportion correct score on the Short Term Memory test in 64C and 71L, the Tracking 1 and Tracking 2 scores in 13B, and the decision time score on the Short Term Memory test in 11B and 31C.

Table 10

Median Semi-partial Correlations, Across MOS, for Significant Predictors of Comprehensive Measures

	Total School/Job	Total Hands-On	General Soldiering	Core Technical	Skill Qual
<u>ASVAB</u>:					
Math Knowledge	.07	.09	.08	.06	.07
Auto/Shop	.13	.14	.12	.14	.11
Mechanical Comp.	.01	.08	.05	.04	.05
General Science	.12	.07	.09	.10	.08
Verbal	.08	-.10	.10	.10	.13
Arithmetic Reas.	.05	-.01	.04	.05	.10
Coding Speed	.06	.15	.03	.04	ns
Number Operations	.07	.13	.08	.12	.12
Electronics Info.	.08	ns	ns	.08	.07
<u>Spatial Ability</u>:					
Assembling Objects	.11	.06	.11	.09	.11
Figural Reasoning	.07	.12	.09	.09	.08
Map	.14	.07	.11	.10	.10
Object Rotation	ns	.12	.09	.10	-.06
Orientation	.08	.09	.06	ns	.08
Maze	.05	.07	ns	-.07	ns
<u>Perc.-Psychomotor</u>:					
Target Id. - % corr	.07	.10	.08	.08	.07
Target Id. - time	.03	.14	.04	.05	.08
Memory - % corr	.11	.08	.11	.07	.14
Number Memory-time	.07	.07	.07	.07	ns
Tracking 2 - dist.	.07	.15	.15	.08	.05
PSA - time	-.08	-.13	-.08	-.01	-.08
Tracking 1 - dist.	-.07	-.03	.06	-.08	.10
Cannon Shoot - time	-.07	.11	.08	-.09	ns
Memory - time	ns	.11	.10	.06	.08
PSA - % corr	.05	ns	.09	.05	.11
Choice RT	.06	-.11	ns	.10	ns
Target Shoot - time	-.07	ns	ns	-.07	-.09
Target Shoot - dist	ns	ns	.04	ns	-.08
Simple RT	ns	.10	ns	ns	ns

<u>Note</u>. Semi-partial r's at Stage 3 of analysis for predictors which were significant at any stage. Some "retained" predictors (see Procedure section) may not be significant at Stage 3. The symbol "ns" is shown for predictors which are not significant in any of the equations.

Table 11

Number of Equations for Which Individual Predictors are Statistically Significant, by MOS, Across Criteria

	MOS (Maximum Possible[a])									
	11B (10)	13B (16)	19E (18)	31C (16)	63B (12)	64C (16)	71L (14)	91A (14)	95B (16)	TOTAL (132)
ASVAB:										
Math Knowledge	10	6	8	12	8	14	12	12	14	96
Auto/Shop	8	10	10	14	10	14	4	14	10	94
Mechanical Comp.	4	4	16	4	4	12	6	6	14	70
General Science	8	4	12	8	2	2	4	4	10	54
Verbal	4	2	6	8	4	8	6	6	8	52
Arithmetic Reas.	2	6	6	4	2	0	10	0	4	34
Coding Speed	2	4	4	2	0	0	2	6	6	26
Number Operations	2	4	2	8	2	2	6	0	0	26
Electronics Info.	0	2	2	2	4	6	2	0	4	22
Spatial Ability:										
Assembling Objects	2	7	6	2	8	6	11	8	11	61
Figural Reasoning	6	0	7	5	2	7	12	7	6	52
Map	7	8	8	0	1	0	5	3	9	41
Object Rotation	1	0	6	0	1	6	2	1	2	19
Orientation	2	2	0	3	0	6	3	1	0	17
Maze	0	1	0	0	2	0	2	0	1	6
Perc.-Psychomotor:										
Target Id. - % correct	9	4	7	6	2	0	3	12	2	45
Target Id. - time	9	5	4	1	5	3	7	2	5	41
Memory - % correct	0	1	0	0	0	13	12	6	3	35
Number Memory - time	2	0	6	2	4	0	4	2	8	28
Tracking 2 - dist.	1	12	2	5	0	1	0	0	4	25
PSA - time	2	4	0	5	2	0	0	2	7	22
Tracking 1 - dist.	0	9	2	0	3	2	3	0	1	20
Cannon Shoot - time	0	0	0	3	6	2	0	6	2	19
Memory - time	5	1	0	8	0	0	0	0	0	14
PSA - % correct	1	0	1	0	4	2	2	0	1	11
Choice RT	0	4	1	0	2	0	0	1	2	10
Target Shoot - time	0	2	1	1	0	0	0	1	3	8
Target Shoot - dist.	0	0	0	0	0	0	2	0	1	3
Simple RT	0	0	2	0	0	0	0	0	0	2

[a] An example of the "maximum possible" is as follows: MOS 11B was evaluated on four overall success measures and one functional category, for a total of 5 - multiplying this by 2 (orders of entry) gives 10 possible equations.

Discussion

A number of basic conclusions can be drawn from the results reported above. First, the use of Project A spatial and perceptual-psychomotor test scores substantially improved the prediction of many criteria, most notably the comprehensive measures. As shown in Table 5, incremental R^2s for predicting Total Score on School and Job Knowledge Tests and General Soldiering Proficiency equaled or exceeded .05 (an arbitrary cut-off) in seven of the nine MOS. Both results tend to support the wide generalizability of Project A incremental validity, since the first measure may involve highly different content across MOS, while the second measures a set of more common tasks, but does so using both written and hands-on scores. It appears, therefore, that the inclusion of some Project A predictors into a general selection equation would lead to a significant improvement in the prediction of performance across a wide range of MOS. In contrast, the usefulness of Project A tests for improving the prediction of the more specific criterion measures is dependent upon the specific MOS. Thus, the value of Project A scores for classification decisions would be a function of the job criticality of these more narrowly defined skills.

With regard to the second research question, the results in Tables 6, 7, and 8 show a slight superiority of spatial tests over the perceptual-psychomotor scores as incremental predictors. However, the results of these analyses give no strong support to the assertion that either group of predictors is, across the board, superior to the other. These results also indicate that the computerized perceptual-psychomotor tests account for criterion variance which is not redundant with the spatial tests. Nevertheless, it should be noted that the perceptual-psychomotor tests, unlike the paper-and-pencil spatial measures, require expensive computer hardware and software and must be administered individually. Thus, the utility of these measures should probably be considered separately with each selection or classification decision.

Concerning the incremental validity of individual Project A tests, some of these tests appear to be much more useful than others. Among the Project A tests of spatial ability, Assembling Objects, Figural Reasoning, and Map show the greatest promise for incrementing ASVAB as a predictor of performance; to this may be added such perceptual-psychomotor tests as Target Identification (decision time and percent correct) and Short Term Memory (percent correct). Other Project A scores, while perhaps not as useful for overall selection, might be utilized as incremental predictors of more specific abilities in certain MOS.

Special note should be taken here of the results for two perceptual-psychomotor tests, Target Tracking 1 and Target Tracking 2. Previous research (Graham, 1988; Smith & Walker,

1988) has shown these tests to be quite useful for predicting firing speed and accuracy with certain types of weapons systems. In the present analyses, however, both tests were only moderately strong incremental predictors overall (see results for Tracking 1 and Tracking 2 in Table 9). Once again, it should be recalled that none of the criteria used here involved the ability to fire a weapons system quickly and accurately.

To interpret these generally positive results properly, it is important to note a number of methodological considerations. First, there is a certain degree of redundancy among some criteria. As stated earlier, individual written and hands-on tests contributed variance to the total written and hands-on scores, respectively, as well as to General Soldiering and Core Technical Proficiency. Along the same lines, some of the more specific criterion measures (e.g., Navigation, Target Identification) form a small part of the more comprehensive criteria, such as General Soldiering and Core Technical Proficiency.

Another consideration is the fact that scores on the ASVAB were "pre-enlistment" and some were used in the selection of recruits; in contrast, those on the Project A spatial and perceptual-psychomotor tests were gathered "for research purposes only" at the same time as most of the criterion measures. Although correction for restriction-of-range in the ASVAB scores (and any implicit in the measures correlated with them) has been accomplished in these analyses, one issue does remain. Possible differences in motivation due to differences in testing situations (i.e., ASVAB scores used for selection as opposed to Project A scores used "for research purposes only") may have impacted the results. That is, individuals may have responded more carefully, exerted more effort, etc., on the ASVAB subtests, thus making them more valid measures of abilities than the Project A tests.

Another methodological concern has to do with the statistical analyses used. Stepwise regression procedures, while useful for empirically exploring alternative models, are especially susceptible to sampling error (cf. Cohen & Cohen, 1983). The samples used in the analyses were generally of sufficient size to make the degree of shrinkage in each <u>individual</u> equation relatively low. However, the large <u>number</u> of equations computed here increases the probabilities that some ASVAB and Project A predictors are significant due to Type I errors. Two points should be made regarding this issue, however. First, an attempt at "hypothesis testing" was made when the more specific criteria were chosen for analysis. Secondly, as shown in the far right column of Table 11, each predictor can be significant a maximum of 132 times, across all criteria, MOS, and orders of entry. At an alpha level of .05, a predictor may be expected to reach significance, by sampling error alone, between

six and seven times. The same column clearly indicates that the majority of Project A tests were significant far more often than this. However, the lack of opportunities at this point for cross-validation renders the results reported in this paper exploratory and suggestive only.

The 1985 Concurrent Validation was only one of several phases in the Army's Project A. The next phase, the Longitudinal Validation which began in 1986/87, will produce data sets, analyses, and results free of many of the concerns listed above. Much larger sample sizes will be available, for example, and all predictor data will have been gathered according to a strictly predictive design. Also, equations can be used to test a limited set of a priori hypotheses (perhaps some based partially on the present results), thus holding down the number of equations computed and the experiment-wide error rate. Based upon the preliminary results reported here, we are optimistic about the findings of the Longitudinal Validation.

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Appendix A

Number of Equations for Which Individual Tests are Significant Predictors of Total Score on School and Job Knowledge Tests, by MOS

	MOS									
	11B	13B	19E	31C	63B	64C	71L	91A	95B	TOTAL
ASVAB:										
Math Knowledge	2	0	2	2	2	2	2	2	2	16
Auto/Shop	0	2	2	2	2	2	0	2	2	14
Mechanical Comp.	2	0	2	0	2	2	2	2	2	14
Verbal	2	2	0	0	2	2	2	2	2	14
General Science	2	0	2	2	0	0	0	0	2	8
Number Operations	2	2	2	2	0	0	0	0	0	8
Electronics Info.	0	0	2	0	2	2	0	0	0	6
Arithmetic Reas.	0	2	0	0	0	0	2	0	0	4
Coding Speed	0	0	0	0	0	0	0	2	2	4
Spatial Ability:										
Assembling Objects	2	2	2	0	2	2	2	2	2	16
Figural Reasoning	2	0	1	2	0	2	2	1	2	12
Map	2	2	2	0	0	0	2	0	2	10
Orientation	0	0	0	2	0	0	0	0	0	2
Maze	0	0	0	0	2	0	0	0	0	2
Object Rotation	0	0	0	0	0	0	0	0	0	0
Perc.-Psychomotor:										
Number Memory - time	1	0	2	2	2	0	2	1	2	12
Target Id. - % correct	1	2	2	2	0	0	1	2	0	10
Memory - % correct	0	0	0	0	0	2	2	1	1	6
Tracking 2 - dist.	0	2	0	1	0	1	0	0	2	6
PSA - % correct	1	0	1	0	2	1	0	0	0	5
Choice RT	0	2	0	0	2	0	0	1	0	5
Target Id. - time	1	1	1	0	0	0	1	0	0	4
PSA - time	0	1	0	0	0	0	0	0	2	3
Target Shoot - time	0	2	0	0	0	0	0	0	1	3
Tracking 1 - dist.	0	1	0	0	0	0	0	0	0	1
Cannon Shoot - time	0	0	0	1	0	0	0	0	0	1
Memory - time	0	0	0	0	0	0	0	0	0	0
Simple RT	0	0	0	0	0	0	0	0	0	0
Target Shoot - dist.	0	0	0	0	0	0	0	0	0	0

Note. Maximum possible: 2 (orders of entry) for all MOS, giving a total of 18.

Appendix B

Number of Equations for Which Individual Tests are Significant Predictors of Total Score on Hands-On Tests, by MOS

	MOS									
	11B	13B	19E	31C	63B	64C	71L	91A	95B	TOTAL
<u>ASVAB</u>:										
Math Knowledge	2	2	2	2	2	2	2	2	2	18
Auto/Shop	2	2	2	2	2	2	0	2	2	16
Mechanical Comp.	0	0	2	0	0	2	0	2	2	8
Verbal	0	0	2	2	0	0	0	0	2	6
Number Operations	0	0	0	2	2	0	2	0	0	6
General Science	0	0	0	0	0	0	0	0	2	2
Arithmetic Reas.	0	0	0	0	0	0	2	0	0	2
Coding Speed	0	0	0	0	0	0	0	2	0	2
Electronics Info.	0	0	0	0	0	0	0	0	0	0
<u>Spatial Ability</u>:										
Figural Reasoning	0	0	0	0	0	1	2	2	2	7
Orientation	1	0	0	0	0	2	2	0	0	5
Object Rotation	0	0	2	0	1	2	0	0	0	5
Map	1	0	0	0	0	0	0	0	2	3
Assembling Objects	0	0	0	0	1	0	1	0	0	2
Maze	0	1	0	0	0	0	0	0	0	1
<u>Perc.-Psychomotor</u>:										
Target Id. - time	2	0	0	0	2	0	0	0	1	5
Memory - % correct	0	0	0	0	0	1	2	1	1	5
Target Id. - % correct	2	0	0	0	0	0	0	2	0	4
Tracking 1 - dist.	0	2	0	0	0	1	1	0	0	4
Memory - time	2	0	0	2	0	0	0	0	0	4
Cannon Shoot - time	0	0	0	0	2	0	0	2	0	4
Tracking 2 - dist.	0	2	1	0	0	0	0	0	0	3
PSA - time	0	0	0	2	0	0	0	0	1	3
Number Memory - time	0	0	1	0	0	0	0	0	0	1
Choice RT	0	0	1	0	0	0	0	0	0	1
Simple RT	0	0	1	0	0	0	0	0	0	1
PSA - % correct	0	0	0	0	0	0	0	0	0	0
Target Shoot - time	0	0	0	0	0	0	0	0	0	0
Target Shoot - dist.	0	0	0	0	0	0	0	0	0	0

<u>Note</u>. Maximum possible: 2 (orders of entry) for all MOS, giving a total of 18.

Appendix C

Number of Equations for Which Individual Tests are Significant Predictors of General Soldiering Proficiency, by MOS (excludes 11B)

	MOS									
	11B	13B	19E	31C	63B	64C	71L	91A	95B	TOTAL
ASVAB:										
Auto/Shop	-	2	2	2	2	2	2	2	2	16
Math Knowledge	-	2	2	2	2	2	0	2	2	14
Mechanical Comp.	-	0	2	0	0	2	2	2	2	10
General Science	-	0	2	2	2	0	2	0	2	10
Arithmetic Reas.	-	2	0	0	0	0	2	0	0	4
Verbal	-	0	0	0	0	2	0	2	0	4
Number Operations	-	0	0	2	0	0	2	0	0	4
Coding Speed	-	0	0	0	0	0	0	0	2	2
Electronics Info.	-	0	0	0	0	0	0	0	0	0
Spatial Ability:										
Assembling Objects	-	1	1	0	2	2	2	2	2	12
Figural Reasoning	-	0	2	2	0	1	0	1	2	8
Map	-	2	2	0	1	0	1	0	1	7
Orientation	-	0	0	0	0	1	1	1	0	3
Object Rotation	-	0	0	0	0	2	1	0	0	3
Maze	-	0	0	0	0	0	0	0	0	0
Perc.-Psychomotor:										
Number Memory - time	-	0	2	0	2	0	0	1	2	7
Memory - % correct	-	1	0	0	0	2	2	0	1	6
Target Id. - % correct	-	0	1	2	0	0	0	2	0	5
Tracking 1 - dist.	-	2	0	0	0	1	2	0	0	5
PSA - time	-	0	0	2	0	0	0	0	2	4
Cannon Shoot - time	-	0	0	0	2	0	0	2	0	4
Target Id. - time	-	0	0	0	1	0	1	0	1	3
Tracking 2 - dist.	-	2	1	0	0	0	0	0	0	3
Memory - time	-	0	0	2	0	0	0	0	0	2
PSA - % correct	-	0	0	0	2	0	0	0	0	2
Target Shoot - dist.	-	0	0	0	0	0	0	0	1	1
Choice RT	-	0	0	0	0	0	0	0	0	0
Target Shoot - time	-	0	0	0	0	0	0	0	0	0
Simple RT	-	0	0	0	0	0	0	0	0	0

Note. Maximum possible: 2 (orders of entry) for eight MOS (excluding 11B), giving a total of 16.

Appendix D

Number of Equations for Which Individual Tests are Significant Predictors of Core Technical Proficiency, by MOS

	MOS									
	11B	13B	19E	31C	63B	64C	71L	91A	95B	TOTAL
ASVAB:										
Auto/Shop	2	2	2	2	2	2	0	2	0	14
Math Knowledge	2	0	2	0	0	2	2	2	2	12
Mechanical Comp.	2	0	2	0	2	2	0	0	2	10
Verbal	0	0	2	2	0	0	2	2	2	10
Coding Speed	2	0	0	0	0	0	2	2	2	8
Electronics Info.	0	0	0	2	2	0	2	0	2	8
General Science	2	0	2	0	0	0	0	2	0	6
Arithmetic Reas.	0	2	0	2	0	0	2	0	0	6
Number Operations	0	2	0	2	0	0	0	0	0	4
Spatial Ability:										
Map	2	2	2	0	0	0	2	0	2	10
Assembling Objects	0	1	0	0	2	2	2	0	2	9
Figural Reasoning	2	0	0	0	0	1	2	2	0	7
Object Rotation	0	0	2	0	0	0	0	0	0	2
Maze	0	0	0	0	0	0	2	0	0	2
Orientation	0	0	0	0	0	0	0	0	0	0
Perc.-Psychomotor:										
Target Id. - % correct	2	0	2	2	0	0	1	2	0	9
Target Id. - time	2	1	1	0	1	1	1	0	0	7
Tracking 2 - dist.	1	2	0	2	0	0	0	0	2	7
Memory - % correct	0	0	0	0	0	2	2	2	0	6
Number Memory - time	1	0	0	0	0	0	2	0	2	5
Tracking 1 - dist.	0	2	0	0	1	0	0	0	0	3
PSA - time	0	1	0	0	1	0	0	0	0	2
Cannon Shoot - time	0	0	0	2	0	0	0	0	0	2
Choice RT	0	2	0	0	0	0	0	0	0	2
Target Shoot - time	0	0	0	0	0	0	0	0	2	2
Memory - time	1	0	0	0	0	0	0	0	0	1
PSA - % correct	0	0	0	0	0	1	0	0	0	1
Simple RT	0	0	0	0	0	0	0	0	0	0
Target Shoot - dist.	0	0	0	0	0	0	0	0	0	0

Note. Maximum possible: 2 (orders of entry) for all MOS, giving a total of 18.

Appendix E

Number of Equations for Which Individual Tests are Significant Predictors of Skill Qualification Test Score, by MOS (excludes 91A)

	MOS									
	11B	13B	19E	31C	63B	64C	71L	91A	95B	TOTAL
<u>ASVAB</u>:										
Auto/Shop	2	2	2	2	2	2	0	-	2	14
General Science	2	2	2	2	0	2	2	-	0	12
Arithmetic Reas.	0	0	2	2	2	0	2	-	2	10
Verbal	2	0	0	2	2	0	2	-	2	10
Math Knowledge	2	0	0	0	0	2	2	-	2	8
Mechanical Comp.	0	2	0	0	0	2	0	-	2	6
Electronics Info.	0	0	0	0	0	2	0	-	2	4
Number Operations	0	0	0	0	0	0	2	-	0	2
Coding Speed	0	0	0	0	0	0	0	-	0	0
<u>Spatial Ability</u>:										
Assembling Objects	0	2	2	2	0	0	1	-	2	9
Figural Reasoning	2	0	0	0	2	0	2	-	0	6
Object Rotation	1	0	0	0	0	0	1	-	2	4
Map	1	0	2	0	0	0	0	-	0	3
Orientation	1	0	0	0	0	2	0	-	0	3
Maze	0	0	0	0	0	0	0	-	0	0
<u>Perc.-Psychomotor</u>:										
PSA - time	2	2	0	0	1	0	0	-	0	5
Tracking 1 - dist.	0	0	2	0	2	0	0	-	1	5
Target Id. - % correct	2	0	0	0	1	0	1	-	0	4
Target Id. - time	2	1	0	0	0	0	1	-	0	4
Memory - time	2	1	0	0	0	0	0	-	0	3
Memory - % correct	0	0	0	0	0	2	0	-	0	2
PSA - % correct	0	0	0	0	0	0	2	-	0	2
Target Shoot - dist.	0	0	0	0	0	0	2	-	0	2
Tracking 2 - dist.	0	0	0	1	0	0	0	-	0	1
Target Shoot - time	0	0	1	0	0	0	0	-	0	1
Cannon Shoot - time	0	0	0	0	0	0	0	-	0	0
Choice RT	0	0	0	0	0	0	0	-	0	0
Simple RT	0	0	0	0	0	0	0	-	0	0
Number Memory - time	0	0	0	0	0	0	0	-	0	0

<u>Note</u>. Maximum possible: 2 (orders of entry) for eight MOS (excluding 91A), giving a total of 16.

Appendix F

Number of Equations for Which Individual Tests
are Significant Predictors of
Navigation, by MOS (excludes 11B)

	MOS									
	11B	13B	19E	31C	63B	64C	71L	91A	95B	TOTAL
<u>ASVAB</u>:										
Math Knowledge	-	2	0	2	2	2	2	2	2	14
Mechanical Comp.	-	0	2	2	0	2	2	0	2	10
Auto/Shop	-	0	0	2	0	2	0	2	0	6
Coding Speed	-	2	2	0	0	0	0	0	0	4
Verbal	-	0	0	0	0	2	0	0	0	2
Electronics Info.	-	2	0	0	0	0	0	0	0	2
Arithmetic Reas.	-	0	2	0	0	0	0	0	0	2
Number Operations	-	0	0	0	0	2	0	0	0	2
General Science	-	0	0	0	0	0	0	0	0	0
<u>Spatial Ability</u>:										
Assembling Objects	-	0	0	0	1	0	1	2	1	5
Figural Reasoning	-	0	2	0	0	0	2	0	0	4
Orientation	-	2	0	0	0	1	0	0	0	3
Object Rotation	-	0	0	0	0	2	0	0	0	2
Map	-	0	0	0	0	0	0	1	1	2
Maze	-	0	0	0	0	0	0	0	1	1
<u>Perc.-Psychomotor</u>:										
Cannon Shoot - time	-	0	0	0	2	2	0	1	0	5
Target Id. - time	-	0	0	0	1	0	2	0	1	4
Memory - % correct	-	0	0	0	0	2	2	0	0	4
Target Id. - % correct	-	0	0	0	1	0	0	2	0	3
Choice RT	-	0	0	0	0	0	0	0	2	2
Memory - time	-	0	0	2	0	0	0	0	0	2
PSA - % correct	-	0	0	0	0	0	0	0	1	1
Target Shoot - time	-	0	0	0	0	0	0	0	0	0
Tracking 2 - dist.	-	0	0	0	0	0	0	0	0	0
Number Memory - time	-	0	0	0	0	0	0	0	0	0
Tracking 1 - dist.	-	0	0	0	0	0	0	0	0	0
PSA - time	-	0	0	0	0	0	0	0	0	0
Simple RT	-	0	0	0	0	0	0	0	0	0
Target Shoot - dist.	-	0	0	0	0	0	0	0	0	0

<u>Note</u>. Maximum possible: 2 (orders of entry) for eight MOS (excluding 11B), giving a total of 16.

Appendix G

Number of Equations for Which Individual Tests
are Significant Predictors of
Target Identification, by MOS (excludes 63B and 71L)

	MOS									
	11B	13B	19E	31C	63B	64C	71L	91A	95B	TOTAL
<u>ASVAB</u>:										
General Science	2	2	2	2	-	0	-	2	2	12
Auto/Shop	2	0	0	0	-	0	-	2	2	6
Math Knowledge	2	0	0	2	-	0	-	0	0	4
Coding Speed	0	2	0	2	-	0	-	0	0	4
Arithmetic Reas.	2	0	0	0	-	0	-	0	0	2
Verbal	0	0	0	2	-	0	-	0	0	2
Mechanical Comp.	0	0	2	0	-	0	-	0	0	2
Electronics Info.	0	0	0	0	-	2	-	0	0	2
Number Operations	0	0	0	0	-	0	-	0	0	0
<u>Spatial Ability</u>:										
Map	1	2	0	0	-	0	-	2	1	6
Assembling Objects	0	0	1	0	-	0	-	0	0	1
Object Rotation	0	0	0	0	-	0	-	1	0	1
Orientation	0	0	0	1	-	0	-	0	0	1
Figural Reasoning	0	0	0	0	-	0	-	0	0	0
Maze	0	0	0	0	-	0	-	0	0	0
<u>Perc.-Psychomotor</u>:										
Target Id. - time	2	2	2	1	-	2	-	2	2	13
Target Id. - % correct	2	2	2	0	-	0	-	0	2	8
PSA - time	0	0	0	1	-	0	-	2	0	3
Tracking 2 - dist.	0	2	0	1	-	0	-	0	0	3
Tracking 1 - dist.	0	2	0	0	-	0	-	0	0	2
Memory - % correct	0	0	0	0	-	0	-	2	0	2
Target Shoot - time	0	0	0	1	-	0	-	1	0	2
Cannon Shoot - time	0	0	0	0	-	0	-	0	1	1
Simple RT	0	0	1	0	-	0	-	0	0	1
Number Memory - time	0	0	1	0	-	0	-	0	0	1
Memory - time	0	0	0	0	-	0	-	0	0	0
PSA - % correct	0	0	0	0	-	0	-	0	0	0
Target Shoot - dist.	0	0	0	0	-	0	-	0	0	0
Choice RT	0	0	0	0	-	0	-	0	0	0

<u>Note</u>. Maximum possible: 2 (orders of entry) for seven MOS (excluding 63B and 71L), giving a total of 14.

Appendix H

Number of Equations for Which Individual Tests are Significant Predictors of Operating Howitzer Sights, Tank Gunnery, and Determining Grid Coordinates, by MOS

	MOS and Criteria								
	13B	19E	19E	31C	64C	71L	91A	95B	Grid
	Howit[a]	Tank	Deter Grid Coordinates						Total
ASVAB:									
Math Knowledge	0	0	0	2	2	2	2	2	10
Auto/Shop	0	0	0	2	2	2	2	0	8
Mechanical Comp.	2	2	2	2	0	0	0	2	6
Arithmetic Reas.	0	0	2	0	0	0	0	2	4
Verbal	0	2	0	0	2	0	0	0	2
General Science	0	2	0	0	0	0	0	2	2
Coding Speed	0	0	2	0	0	0	0	0	2
Electronics Info.	0	0	0	0	0	0	0	0	0
Number Operations	0	0	0	0	0	0	0	0	0
Spatial Ability:									
Figural Reasoning	0	0	2	1	2	2	1	0	8
Assembling Objects	1	0	0	0	0	2	2	2	6
Object Rotation	0	2	0	0	0	0	0	0	0
Map	0	0	0	0	0	0	0	0	0
Maze	0	0	0	0	0	0	0	0	0
Orientation	0	0	0	0	0	0	0	0	0
Perc.-Psychomotor:									
Memory - % correct	0	0	0	0	2	2	0	0	4
Target Id. - % correct	0	0	0	0	0	0	2	0	2
Number Memory - time	0	0	0	0	0	0	0	2	2
PSA - time	0	0	0	0	0	0	0	2	2
Cannon Shoot - time	0	0	0	0	0	0	1	1	2
Memory - time	0	0	0	2	0	0	0	0	2
Target Id. - time	0	0	0	0	0	1	0	0	1
Tracking 2 - dist.	2	0	0	0	0	0	0	0	0
Tracking 1 - dist.	0	0	0	0	0	0	0	0	0
Choice RT	0	0	0	0	0	0	0	0	0
Target Shoot - time	0	0	0	0	0	0	0	0	0
PSA - % correct	0	0	0	0	0	0	0	0	0
Simple RT	0	0	0	0	0	0	0	0	0
Target Shoot - dist.	0	0	0	0	0	0	0	0	0

Note. Maximum possible: 2 (orders of entry) for eight MOS, giving a total of 16. [a] HOWIT = Operating Howitzer Sights; TANK = Tank Gunnery.

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